2. LUDWIGIANTHA.

[*Ludwigia*, section *Ludwigiantha* T. & G. Fl. N. A. 1: 526. 1840.]

1. LUDWIGIANTHA ARCUATA (Walt.).

Ludwigia arcuata Walt. Fl. Car. 89. 1788.
Ludwigia pedunculosa Michx. Fl. Bor. Am. 1: 88. 1803.
Isnardia pedunculosa DC. Prodr. 3: 60. 1828.
Swamps and marshes, Virginia to Florida.

3. LUDWIGIA L. Sp. Pl. 118. 1753.

Represented by fifteen species in the southern United States.

An ecological Study of the Genus Talinum with Descriptions of two Species.

BY J. W. HARSHBERGER.

(PLATE 299.)

There are admitted by Engler and Prantl in their voluminous work, "Die Natürlichen Pflanzenfamilien," seventeen genera of the family Portulacaceae, and, according to the Index Kewensis, the distribution of the species of these several genera is as follows:

Genus.	Number of Species.	Western Hemisphere including N. and S. America and Islands.	Eastern Hemisphere including Asia, Africa, Europe and Oceanica.
1. Talinum	30	25	5
2. Calandrinia . .	125	100	25
3. Spraguea . . .	2	2	—
4. Calyptridium. .	3	3	—
5. Talinopsis . . .	1	1	—
6. Pleuropetalon .	2	2	—
7. Grahamia . . .	1	1	—
8. Anacampseros .	12	—	12
9. Claytonia . . .	25	21	4
10. Hectorella. . .	2	—	2
11. Montia	—	—	—
12. Monocosmia . .	2	2	—
13. Silvaea	4	4	—
14. Portulacaria . .	2	—	2
15. Talinella . . .	1	—	1
16. Portulaca . . .	54	20	34
17. Lewisia	2	2	—
	268	183	85

STUDY OF THE GENUS TALINUM.

It is at once apparent from an inspection of this table, that more than one-half of the genera are American, and of those found in the eastern hemisphere all are represented by species in the western hemisphere. Out of a total number of 268 species in 16 genera, 183 species are confined to the western hemisphere and 85 species to the eastern. The larger number of species of the eastern hemisphere, numbering some 71, belong to three genera *Calandrinia*, *Anacampseros* and *Portulaca*. Broadly speaking, the order Portulacaceae is an American order, and is interesting to the botanist morphologically, as well as ecologically. There is no more interesting genus from an ecologic standpoint than the genus *Talinum*.

It will be seen, if the American species of this genus are arranged geographically, that the greater number of well-defined species range from Chili and Peru, where proportionally the greatest number of species is found, through Mexico where the genus is represented by at least 5 species to western North America to New Mexico and Texas.

Country.	Number of Species.
Chili	6
Peru	2
Venezuela	1
Am. trop	2
Mexico	5
Am. bor. occ	4
N. Mexico	1
Texas	2
Ind. or	1
Am. bor.	3

The greater majority of the species of the genus *Talinum* range, therefore, along the backbone of the continent, and the species are discovered in greatest abundance in Mexico and western South America. A few species are isolated, and are separated from the main regiment as stragglers. *Talinum teretifolium* is one of these species, ranging over the eastern and central United States. From Prof. Thos. C. Porter, I learn that in the Herbarium of Lafayette College there are specimens of *Talinum teretifolium* collected in the following localities, in addition

to the commonly known one on the serpentine ranges of Chester County, Pennsylvania.

1. Dunn's Mt. and Roan Mountain, N. C. (Small.)
2. Sapulpa, Indian Terr. (B. F. Bush.)
3. Summit, Yonah Mt., Ga. (T. C. Porter.)
4. Sandy Barren, Oquaka, Ill.
5. Arena, Wisconsin.
6. Little-Stone Mt., De Kalb Co., Ga.
7. Rocky Knob, Caldwell Co., N. C.

The following observation by Mr. E. J. Hill is to the point.* *Talinum teretifolium* was found in 1832 on rocks above Taylor's Falls. "It is occasionally met with from Pennsylvania westward to Minnesota in our northern flora, being more common in Minnesota than elsewhere in this range of States." It has also been found at Miller's, Lake County, Indiana. In Illinois, it is found in sandy prairies and barrens. This disconnected distribution in isolated patches of country is hard to explain, unless we accept two propositions, both of which, or either of which may suffice as an explanation. 1. That its distribution as a species is due to the lightness of its seeds. 2. That being at one time a wide spread plant, it has been destroyed over the greater part of its range with the exception of a few localities, where it is still pretty abundant.

It is important also to draw attention to the distribution of the plant as influenced by the soil or rock formations. It is found abundantly in some places on the serpentine outcrops in Chester County, where I have observed its growth. These serpentine outcrops trend in a general southwesterly direction through Delaware and Chester counties, reaching their greatest extent in Pennsylvania on the Maryland line. These serpentine outcrops are essentially rocky oases, which have in some respects a peculiar flora. These barrens are characterized by the presence of the Red Cedar, *Juniperus Virginiana*, which, although scattered elsewhere in the neighborhood, is never so abundant, nor so closely grouped, as on these stony places. Not all of the serpentine barrens have the same association of species, for instance, *Cerastium oblongifolium* and *Talinum teretifolium* are not found on all of the serpentine ledges, but are localized to particular ones. So it is with other

* 1891. E. J. Hill, Botan. Gaz. 16 : 112. Notes on Flora of St. Croix Region.

associated species. They may be abundantly present in one spot, but absent in another. These facts make the study of the flora of the serpentine barrens especially inviting. According to Dana,* serpentine is a hydrous magnesium silicate like talc, but containing more water and less silica. It is of a green color, often clouded and has been made through the alteration of anhydrous magnesian silicates, as chrysolite. It is used as a building material in Philadelphia, the main college hall of the University of Pennsylvania being built of it. Because the plant *Talinum teretifolium* is confined in Eastern Pennsylvania to soil formed by the decomposition of serpentine rocks, it is interesting to inquire whether the chemical composition of the rocks has anything to do with its distribution, especially, as magnesium is so prominent an element in the rock's constitution. The first analysis of the plant made from meagre material by Dr. Owen Shinn of the Harrison Chemical Laboratory (Univ. of Pa.) led me to believe that such was the case. Farther analysis with more abundant material made by Prof. Henry Trimble, of the Philadelphia College of Pharmacy, led to a somewhat different opinion. His letter submitting the analysis is here quoted. "The overground portion contained so much water that there was not enough material in which to more than determine moisture and ash.

	Moisture	Ash in Absolutely Dry Substance.
Overground portion	86.65%	13.63%
Underground portion	24.12%	11.15%

"The ash of the underground portion consisted of potassium sulphate and potassium chloride, also calcium and magnesium phosphate, the magnesium phosphate being very abundant. The ash of the overground portion contained the same compounds, but apparently in different proportions from what there existed in the underground portion, potassium chloride being in this overground portion in great abundance. How this plant gets so much potassium from a magnesian soil is almost a mystery. Certainly it is interesting." It is known that potassium has to do with the formation of carbohydrates. If a plant does not find any potassium in the soil its growth ceases, and the leaves do not de-

* 1886. Dana, Manual of Mineralogy and Petrology (1894) 330.

velop the power of starch formation within the chlorophyll grains. As starch is stored abundantly in *Talinum teretifolium*, it may be that the potassium chloride plays this rôle, but this has not been certainly determined. It is interesting, however, to note that the phosphate of magnesium is present in the perennating stem, having been taken up by the roots. Whether its presence in the plant determines the plant's distribution is still a physiological enigma.

The plant has been recorded from other formations. Gray's manual says serpentine rocks. Upham* records it as occurring on ledges of rock (trap, syenite, granite and quartzite). It was found by Hill in the silicious sands at Miller's, Lake County, Indiana. In Illinois, it is found on sandy prairies and barrens. At Taylor's Falls, three other plants are associated with it on trap rocks, viz.: *Campanula rotundifolia*, *Selaginella rupestris* and *Cladonia rangiferina*. A mention of the habit of the plant in other places than southeastern Pennsylvania shows that *Talinum teretifolium* chooses many different soil formations, and the name of one locality Arena, Wisconsin, is suggestive.

Several species of the genus *Talinum* were found by me in Mexico this last summer growing on the bare faces of rocks. On the Cerrode Guadalupe, a rocky hill on the south front of which is situated the Holy Shrine of "Our Lady of Guadalupe" (Nuestra Senora Guadalupe) were found two species on the face of the weather worn rocks, namely *T. patens* and *T. aurantiacum*. These plants grew in an extremely dry situation, and exposed to the full blaze of the sun. The flat succulent leaves of *T. patens* were rolled up at their edges, so that the plant had a peculiarly curled appeared. This was no doubt an adaptation on the plant's part to meet the direct rays of the sun. The root of this plant is large, fleshy and succulent, and penetrates to a considerable depth (8–10 in.) into the crevices of the rocks. *T. aurantiacum* is consolidated more than *T. patens*, and has a strong swollen taproot, somewhat tuber-like in appearance. The leaves are linear, thick and grooved by two longitudinal grooves, as if the margin had been inflexed. Two other Mexican species *T. Greenmanii* and *T. napiforme* were discovered on exposed volcanic

* 1891. Upham, Botan. Gaz. 16: 112.

rocks. *T. Greenmanii* occurs on volcanic ground, Sierra de Ajusco, 8500 feet altitude; *T. napiforme* in the Pedrigal at Thapam, 7300 feet altitude. Both of these plants are succulent, consolidated and well adapted to stand the long periods of draught which are the rule in these volcanic regions. The roots penetrate into the volcanic pockets, where they find enough of soil for their needs. The leaves of both are terete, clustered at the base and surround a much abbreviated flower-stalk. It is interesting to note, that two other species of the genus, namely *T. confertiflorum*,* and *T. humile*,† are found in the Pinos Altos mountains, New Mexico. Another species, *Talinum spinescens*, is also adapted to dry situations, as shown by its dwarf habit and terete leaves. It was discovered by T. S. Brandegee on bare hills east of Ellensburgh, Washington.

Before describing the particular structure of *Talinum tereti-folium*, as determined by microscopic examination, it is expedient to describe the two species, one new, found by me this summer while botanizing with the veteran collector and botanist, Mr. C. G. Pringle.

1. TALINUM NAPIFORME DC.

Roots perennial, somewhat tuberous, 1–2 in. long, ½ in. broad, swollen with rounded button-like knobs and covered with corky scales of a dark brown color and bronze-like lustre; scales protective, root fibres long and rooting in the crevices of the rocks; acaulescent; leaves terete, smooth, waxy-green, flattened at base, rounded acute, 1–2½ in. long, clustered at top of root; scape 3–8 in. tall, cymosely many-flowered; bractlets small, sessile, acute; flowers small, ½ in. across; sepals 2;‡ petals 5,§ white veined with purple; stamens 5; ovary short, rounded; style short; stigma capitate, hispid; fruit small, $\frac{1}{9}$ in. long, 3-cornered, sutural dehiscence; seeds small, black, spirally grooved. (Plate 299, fig. 3.)

Valley of Mexico, Tlalpam, Pedregal, growing on volcanic rocks. Resembling *T. confertiflorum* of E. L. Greene. Distributed in Pringle's Plantae Mexicanae as no. 6487.

2. TALINUM GREENMANII n. sp.

Tap-root spindle-shaped, forked or straight, 2 in. long; acaules-

* E. L. Greene, Bull. Torr. Club, 8: 121.

† E. L. Greene, Bot. Gaz. 6: 183.

‡ Called bracts by Warming.

§ Called perianth by Warming.

cent, or with stem 1–2 in. long; leaves terete, 1–3 in. long, acute, green, clustered at top of short stem; inflorescence cymose not exceeding the leaves, branched with 5–8 flowers; sepals 2; petals 5; bright yellow; stamens 7–8, filaments long; ovary round; style short; stigma three-grooved; fruit rounded, triquetrous; seeds, small, smooth. (Plate 299, fig. 4).

Volcanic gravel, Sierra de Ajusco, Mexico. 8500 feet. Possibly it is *T. humile* described by E. L. Greene. Distributed in Pringle's Plantae Mexicanae as no. 6472. Named in honor of Mr. Jesse Moore Greenman, of the Gray Herbarium, Cambridge, Mass.

Talinum teretifolium belongs to that group of the genus with round leaves, as distinguished from those species which have leaves more or less flattened, as *T. patens, lineare* and *brevifolium*.* *Talinum teretifolium* is interesting not only on account of its geographical distribution, but also from its significance from an histological and ecological standpoint. The stem is tuberiform, provided with closely appressed scale-leaves (induviae). During the active growing season, the perennating stem becomes more or less elongated, from which the green succulent stem arises bearing the terete foliage leaves. In the fall, just before the cessation of growth, rounded, tuberiform branches appear, which finally break from the main perennating stem as the plant withers. These small tuberous branches remain dormant during the cold of winter, their contents being protected by a thick corky layer until spring opens, when they give rise to new foliage shoots. One of these tuberiform branches, or stems, was planted in a pot January 21, 1896, and watered carefully to determine whether these branches propagated the plant non-sexually. On March 25, 1896, a green outgrowth appeared. By the end of March the green sprout had reached the height of an inch and had eight well-formed terete leaves. (See Plate 299, fig. 2). It is probable, also, that these ball-like branches aid in the distribution of the plant, rolling from place to place.

Histology. The root is long, and in cross section is surrounded with cork from six to eight layers thick. As the long, elastic roots are exposed frequently to the drying action of winds, this cork envelope becomes all the more necessary. Internal to the

*1893. Thomas Howell, A Rearrangement of American Portulacaceae. Erythea, 1: 34.

cork, the cortex is found surrounding the central bundle, or stele. The stem consists of two distinct regions, a lower induviate, perennating, cork protected portion, and an upper green foliage portion. The cork in the lower portion is many layers thick, and when sections are cut and mounted in acetic acid as a preservative, the cork cells are found, after the lapse of a year, to have undergone a change. The walls are found covered with peculiar yellowish beads in chains. The appearance which the walls assume reminds one strongly of a suberized cell-wall, which has been acted upon by potash. The cause of this beaded appearance in *Talinum* is not known. It is probably caused by the long action of the acetic acid.

The cortex of the lower perennating portion consists of parenchyma cells which are filled with starch, as a reserve material. If specimens of *Talinum teretifolium* are gathered when the active storing of starch begins, beautiful leucoplasts in which are imbedded compound, or aggregate starch grains are discovered. In the thicker stems, no chlorophyll is found, except in the region immediately beneath the corky envelope. The bundles of the tuberiform stem are collateral, the phloem is present as soft bast, which in the green foliage portion of the stems adds on the outside some bast fibres for support and strength. In the green portion the cork has disappeared.

The bundles of the scape of *Talinum teretifolium* illustrate that the development of the various cells of the mechanical tissue is dependent upon the strain imposed upon them. Consequently, the bast fibres here become clearly accentuated and are of a glistening white color, closely investing the wood by a continuous ring. Beneath the epidermis, collenchyma for strength is also found.

The leaves are terete, 1–3 in. long, sessile with a flat base. In section, a leaf is somewhat crescentic at the base, the xylem portion of the vascular strand is toward the upper surface, and the bast toward the lower face. The bast fibres at the base of the leaf are conspicuous for strengthening purposes, and their cell-walls are of a yellowish tinge. A more distal section is the same as to the position of the elements, but the thickened bast elements are wanting. Beneath the epidermis, a zone of chlorophyll tissue

completely surrounding the leaf is seen, and if a section be cut near the apex, the chlorophyll is found to reach completely to the bundle, which is not the case farther down. The guard cells of the stomata are slightly sunken and, when viewed from above, are together somewhat ellipsoidal in shape.

The rounded succulent leaves with slightly depressed stomata and waxy bloom are well adapted to withstand the hot suns which beat in summer on the bare exposed ledges of serpentine in Chester county, Pennsylvania. Of *Talinum humile*, *confertiflorum*, *Greenmanii*, *napiforme*, *spinescens* with terete leaves, the same thing may be said. In the flat-leaved Portulacaceae, although the leaves are somewhat fleshy, the same adaptation is not so clearly marked.

A repetition of the observation made above on *Talinum patens* needs to be repeated at this point. I found this plant growing on a rocky hillside with a southern exposure called Cerrode Guadalupe in the Valley of Mexico. The leaves in the hot sun of midday were found more or less inrolled, thus giving to the plant a remarkably curled appearance. I have no doubt, although my observations did not extend long enough to fully justify the conclusion reached that, as in other plants, the leaves were inrolled as a protective adaptation. An observation of Mr. Meehan, on the night closing of the leaves of purslane, shows that such motions do occur in the Portulacaceae. Mr. Meehan notes* (Proc. Phila. Acad. Nat. Sci.) that in the list of plants having diurnal or nocturnal motion *Portulaca oleracea* does not appear. "At sundown the leaves at other times at right angles with the stem rise and press the upper surface against it. The morning ex' ansion begins with dawn, and soon after sunrise the leaves are fully expanded. Mr. Isaac Burk has observed the same thing, not only in *Portulaca* but also in an allied plant of the West Indies, *Talinum patens*." The last observation of Mr. Burk shows that in *T. patens* the motion of the leaves is effected either by the approach of night, or by too great illumination and heat. These facts are in line with the behavior of other plants, notably certain sensitive Leguminosae. Vilmorin says of this plant that "It keeps fresh in spite of heat and drouth, and will grow vigorously on unshaded rocks."†

*1882. Meehan, Bull. Torr. Club, 9 : 153.

† Les Fleurs de pleine Terre, 1124.

The inflorescence is a dichasium. In *Talinum teretifolium* it is tall and much branched; in *T. napiforme* the stalks are thin and wiry; in *T. Greenmanii*, the inflorescence scarcely rises above the leaves.

The flowers in *Talinum teretifolium* are small (⅔ in. broad), with two sepals or, as some morphologists would have it, two bracts and five petals, or a five parted perianth with parts imbricately arranged. The petals are of a bright rose-purple, ephemeral; stamens 15–20; capsule globular, triquetrous, three-valved, many-seeded. The flowers open regularly at a definite time during the flowering period. Darlington, in his Flora Cestrica (3d ed. p. 35), says, "Flowers bright purple, appearing in succession opening in sunshine at midday for three or four hours, then closing and shriveling." Mr. Meehan observes the same thing more accurately. He finds* that its flowers always open regularly at 1 P. M.; though for one season they closed promptly at 2, and the next time between 2 and 5 P. M.† In order to finally decide the matter as to opening of the flowers in this species, a visit was paid by me to a serpentine outcrop near Westtown, Chester County, Pa., on June 24, 1896.

Observations on the spot, the day being warm and bright, showed me that the flowers opened between 12:30 and 1 P. M., when the flowers were visited by certain hymenopterous insects, namely the male of *Calliopsis flavipes* Smith, and the female of *Calliopsis andreniformis* Smith.‡

The other species of *Talinum* differ from *T. teretifolium*, as to the time of opening of the flowers, so that this peculiarity of the plants is specific. E. L. Greene says,§ with reference to *T. humile*: "The flowers at 2 o'clock P. M., had not yet opened, hence it is one of those species whose flowers open at evening and close in the morning." Prof. Trelease very kindly had one of his pupils make some observations for me on *Talinum patens* growing in the Missouri Botanical Garden. In a letter to me, dated Aug. 7, 1896, he says: "The flower was fully open at 3:15, and by 4:39

* 1881. Meehan, Bot. Gaz. 6. 280.

† E. J. Hill, Bot. Gaz. 16: 112.

‡ These insects were determined for me by William Fox, of the Academy of Natural Sciences, Phila.

§ Bot. Gaz. 6: 183.

nearly all of the flowers far enough advanced to open, had fully opened. At 6:00 P. M., none had closed. When the next observation was made at 7:30, nine-tenths of the flowers had closed, and by 7:45 all were closed."

UNIVERSITY OF PENNSYLVANIA.

Explanation of Plate 299.

FIG. 1. *Talinum teretifolium*, showing induviate stem, and copiously branched dichasium.

FIG. 2. Tuberiform branch of *T. teretifolium*, produced in the fall of 1895, and sprouted in the spring of 1896.

FIG. 3. *Talinum napiforme* DC.

FIG. 4. *Talinum Greenmanii* n. sp.

Rarities from Montana.—I.

BY P. A. RYDBERG.

(PLATES 300, 301.)

ALLIUM FIBROSUM n. sp.

Bulb with a fibrous coating; stem 2–3 dm. high, subterete, somewhat striate; leaves flat, thickish, 3 mm. wide, 1–1½ dm. long; umbel with numerous bulblets and few flowers on pedicels about 1 cm. long; perianth-segments lanceolate-oblong, obtuse, 6 mm. long; filaments slightly dilated below, ¼ shorter than the segments, and a little longer than the style; anthers oblong; ovary evidently 6 crested, with short rounded crests. (Plate 300.)

This somewhat resembles *A. Canadense*, from which it is distinguished by the smaller size, the bright red bulblets, and the crests of the ovary. From *A. reticulatum* and *A. Geyeri*, it is easily distinguished by the presence of the bulblets. Collected on a high dry mountain side near Lima, Mont., June 29, 1895, by P. A. Rydberg, (no. 2606).

ALLIUM SIBIRICUM L. Mant. 562. 1767. (*Allium Schaenoprasum* β L. Sp. Pl. 301. 1753. *Allium Schaenoprasum* Authors.)

This has generally been confused with *Allium Schaenoprasum*, but it is evidently a good species. It is much taller than that plant, being generally 5–6 dm. high, has only one basal leaf and generally several stem-leaves, these thick, about 5 mm. in diameter, and broader perianth-segments. *Allium Schaenoprasum* is only 2–3 dm. high, and its base is surrounded by many narrow leaves.